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ABSTRACT

Mandatory introductory level college courses, or "service courses," tend to be taught in lecture format, in a linear order from the instructor's point of view, and to classes of anywhere from 50 to 600 or more students. Students have individual differences and diverse learning styles which are difficult to address in a large class. Computer-based instruction can help overcome these constraints by adapting the content of the basic required courses to contexts relevant for the student, and by allowing the student to choose the most personally relevant context at the time of instruction. The learner-controlled format allows learner choice of lesson sequence, pacing, content, and other instructional variables that are adaptive to cognitive styles and prior knowledge. This gives the learner a sense of ownership of content, promoting relevancy and knowledge acquisition. A theoretical framework and foundational research are discussed. A pilot study was conducted of undergraduate students enrolled in a required introductory computer science class. Eighty-one of 140 students (72%) completed all parts of the study. A pre-attitude survey contained questions about demographics and most and least preferred context. The subjects were randomly assigned to three treatment groups, in which subjects were administered the program through: (1) their most preferred choice of context, (2) their least preferred choice of context, and (3) the abstract lesson, with no context. An attitude/motivation survey was conducted before and after the instruction to assess changes in students' attitudes/motivation towards the subject matter. A no-context achievement post-test testing recall, application, synthesis and evaluation of the concepts learned in the lesson was given to all participants. (Contains 24 references.) (SWC)

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Title:

Creating Personal Relevance through Adapting an Educational Task, Situationally, to a Learner's Individual Interests

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Preface:

"Introduction to Computing (Cmpsc101)" is an undergraduate introductory course that enrolls roughly 1700 students per year from widely diverse nontechnical fields. For most students, "Intro. to Computing" is their only exposure to the Computer Science discipline. The students are taught to design, code, and test what are for an introductory course, fairly sophisticated programs, which are structured, modular, and thoroughly documented. This course meets most of the requirements for an introductory Computer Science course, as described in the American Computing Machinery "ACM '78" paper. "Intro. to Computing" is one of many undergraduate courses that deal with quantitative subject matter at an introductory level and that students are required to take as a general education requirement. Due to large class sizes, instructors of such courses often have difficulty involving students actively in the learning process during class time, let alone adapting course content to students' personal interests and goals in order to make learning more meaningful. Students, for the most part, retain the subject matter long enough to pass the final exam which results in inert, unprocessed, and therefore unusable knowledge. CBI (computer-based instruction) can play a key role in solving such problems by contextualizing the content of instruction to the most relevant and current interests of each student. By providing interestingly relevant contexts, and learner choice of context, the locus of control is placed with the student and not the instructor. This instructional strategy enables students to relate content to personal experiences and preferences and therefore construct personally meaningful knowledge that is usable and transferrable to new situations in the future.

Introduction:

Most college courses can be described as having an instructional core with supplemental features. For example, in one course the core might be the lectures, with text(s) considered supplemental and useful only to the extent that they elaborate on the materials covered fully in lectures. In another course, labs might be the core while lectures and texts would be peripheral. Introductory undergraduate courses are no different. Large college institutions refer to these courses as "service courses" due to the fact that students enrolled in them are non-majors to the discipline being taught, but are required to take them as foundational to their major, or as a general education base. Service courses are generally taught in lecture halls that seat anywhere from 50 to 600 (or more) students and the subject matter covered is usually domain general knowledge. Instructors typically use projection devices or movable blackboards as teaching aids, and spend most of the period lecturing from a platform through a microphone. Some of those courses offer small group "recitation classes" to help the students in understanding or applying the subject matter. This is where the "examples" and "applications" of the content are explained or demonstrated.

The format and teaching techniques described above have one thing in common: courses are organized in linear order from the instructor's point of view and therefore every student receives the same instruction at the same pace using the same context. One instructional certainty is that the way in which an expert organizes a body of knowledge is not the same as the way that a novice does (Glaser, 1985). Another instructional certainty is that what might be a relevant and meaningful context for one student is not necessarily relevant and meaningful to another. The list goes on. All to say... and this is hardly revolutionary... that the focus must be on the student's learning and especially on the diversity of ways in which students learn. However structuring a course around students' diverse learning styles and individual differences becomes very problematic in a large class. The purpose of this dissertation study is to show how computer technology can help in overcoming such constraints by adapting the content of "service courses" to interestingly relevant contexts and allowing the student to choose the most personally relevant context at the time of instruction. While this adaptive strategy does not cover many of the individual differences that impact learning, it follows a learner control format of providing learner choice of context, which can be modified or extended to provide learner choice of lesson sequence, pacing, content structure, and other instructional variables that are considered adaptive to cognitive styles and prior knowledge. This approach gives a sense of ownership of content to the learner and promotes relevancy.

Theoretical Framework:

Robert Yager (Yager, 1989) provides a rationale for using *"personal relevance"* (defined by Eisner (Eisner, 1985) as an orientation for the science curriculum which emphasizes the primacy of personal meaning for students by developing programs that focus on their interests and personal experiences) as the primary focus and organizer for planning a science curriculum in schools. He argues that personal meaning and understanding precedes *"social adaptation"*

(defined by Eisner (1985) as an orientation for curriculum planning that focuses on societal concerns) of individuals making other orientations (Eisner, 1985) defines five basic orientations for the school curriculum: personal relevance, social adaptation and reconstuction, academic rationalism, technology, and development of cognitive processes) for curriculum planning in science inappropriate due to their inability to promote a useful understanding of the discipline and a positive attitude or desire among students to study more science. He goes on to argue that typical school programs that are planned by curriculum developers, textbook companies, and individual teachers, do not seem to take into consideration the student, his/her interests, motivations, and personal experiences. Yager believes that a *personal relevance* approach to designing a science curriculum would resolve such issues as well as past failures of science education. Eisner (Eisner, 1985) supports this argument by stating that students must have some investment in the learning experience for it to become educational. Students must actively participate and share in curriculum development in order to make real choices available otherwise *"schooling is likely to be little more than a series of meaningless routines, tasks undertaken to please someone else's conception of what is important"* (Yager, 1989). Eisner likens the *personal relevance* orientation to "open schools" (lack of domain structure) and to programs organized around student interests.

If one were to espouse the above approach, then structuring a science curriculum, or any curriculum, around students' interests and personal experiences is not an easy task. The unique and individual interpretation of educational tasks is largely dependent on prior knowledge and the construction and reconstruction of the activities that students engage in for experimental purposes (Renninger, 1992). Individual interest as defined by Renninger includes both the stored knowledge and the particular relation (value) of the individual with the task relative to other activities that he or she engages in. Since interest is expected to vary between individuals and therefore influence the way in which they act, a strategy is needed to identify individual interest and match the educational task to the particular interest in order to increase *personal relevance.*

Whereas Renninger operationalizes the definition of interest by emphasizing the contributions that individual differences bring to the understanding of an educational task (knowledge/value system), Hidi (Hidi & McLaren, 1990) takes a different perspective on how interest affects learning or cognitive performance and that is through the *interestingness* of the context or what has been termed by Krapp (Krapp, 1989a) as *situational interest.* The focus of situational interest is on the environment and the features or characteristics of the stimuli present in the environment, verses the individual and his or her personal knowledge and values. Interestingly, the interaction between personally generated interest (individual interest) and environmentally generated interest (situational interest) is crucial to both perspectives (Hidi, 1990; Hidi & Baird, 1986). A particular form of situational interest is known as text-based interest. Interest is elicited by using *interesting* analogies and examples in certain text segments, and through ideas, topics, and themes that are relevant to the educational goal. Research results on text-based interest can be described as increasing motivation and comprehension but not enhancing overall learning unless coupled with other organizers of text such as structural features (Hidi & McLaren, 1990).

Key Argument:

Building on both perspectives of interest, situational verses individual, the researcher proposes that the interaction between situational interest and individual interest is a crucial factor in promoting increased motivation, and effective knowledge acquisition and transfer. Individual interest in an educational task or activity will motivate the student to engage in the learning process, and situational interest will provide the authenticity and real world significance of the task to provide a meaningful experience and *personal relevance*. The key factor here is adapting the educational task, situationally, to students' individual interests. The question is then how do educators choose educational contexts that are relevant to students' individual interests and adapt the educational task situationally to those contexts?

Let's start by operationalizing the concept of individual or personal interests. Personal interests lie on a continuum ranging from internally generated interests to externally generated interests, with internally generated interests beginning with personal beliefs, values, and concerns, and extending to the surrounding environments and beyond (see figure A).

Figure A

See Appendix A of the 1996 AECT Proceedings

Personal Interests Continuum

Individual interests can be driven by one or many of the personal, social, or environmental structures provided in the above continuum but the affordances (optimal opportunities) that each of these structures provide, and the unique interaction of an individual with these affordances, will dictate the *most highly-valued* interest at a particular point in time.

There is also a certain degree of overlap among internally generated and externally generated interests and a ripple effect is created if one takes a circular view of the continuum. To illustrate, Lewin (Lewin, 1935) defines the life space of an individual as a mental sphere that consists of the person and the psychological environment that exists for that person at any given time. Life space is the extension of the individual from the personal dimension to the social and environmental dimensions and is dynamically influenced by the needs within each dimension and the interpersonal interactions among those needs. Personal interests therefore, *change*, based on the movement of the individual in the life space (see figure B).

Figure B

See Appendix A of the 1996 AECT Proceedings

Lewin's Visualization of the
Life Space of an Individual

Contexts for educational content can be created to match the personal, social, and environmental dimensions of the life space of an individual and students can freely select the most personally relevant context depending on their location on the "personal interests" continuum and the foreseeable affordances that a particular context might bring.

Creating Educational Contexts Based on Interest:

Herndon (Herndon, 1987) investigated learner interests as a variable that can enhance motivation in learners and incorporated students' interests in an instructional unit on how to solve conditional *syllogisms* (a form of reasoning in which from two given or assumed propositions called the premises & having a common or middle term a third is deduced). He collected data from an interest survey given to all the students that participated in the study and built the interests inventory using the most frequently reported learner interests. He used this inventory to structure the examples of the 'interests' version of the instructional unit and found that significantly more subjects in this group were willing to return to the task of solving syllogisms than the subjects in the 'no interests' version of the instructional unit. The interest survey was based on the work of Sarbin (Sarbin, 1964) who described human experience as an interaction of five 'ecologies' or facets of the environment within which the individual 'forms collections of highly valued interests'. The ecologies or environmental spheres according to Sarbin are: Self-Maintenance (objects and activities), Spatial (places), Social (persons), Normative (knowledge and skills), and Transcendental (ideas and beliefs). Five questions were asked in the survey that were derived from four ecologies. The questions asked for three favorite possessions, three things one likes to do best, three places that one likes best, three highly valued persons, and three things in which one has a valued knowledge or skill.

Selecting contexts for educational content can take on a similar process by conducting a survey on a subset of the experimental population that asks students to prioritize knowledge domains such as science, social studies, and/or humanities, from most interesting to least interesting based on their desirability as an educational context for introductory, quantitative subject matter. The domains will represent the personal, social, and environmental dimensions of the life space of an individual using the structures of the "personal interests" continuum defined above. For example, sociology might be a context that represents the social dimension and incorporates issues dealing with the family and the community. Daily life might be a context that represents the personal dimension and incorporates issues such as personal beliefs and well being. Fiction might be a context that represents the environmental dimension and incorporates transcendental or supernatural issues. An inventory of contexts can be included in the survey and contexts with high ratings will be identified as most relevant to students' interests. Educational tasks can then be contextualized to all or part of the selected contexts depending on the need and applicability of the particular course content.

Let's suppose that six educational contexts have been identified as highly relevant to students' interests: science, daily life, education, business, sociology, and the arts. Computer-based instruction can present this inventory of contexts to students enrolled in an introductory course and students will be asked to select their most preferred context for learning the subject matter of that course. The content can then be contextualized to the most preferred context. This process can be repeated each time the student interacts with the instruction. Individual interest will be promoted through choice of context and situational interest through contextualizing of content. The resulting interaction will increase the valence (perceived challenges or possibilities) of the task and the student can then take advantage of such a learning strategy to construct meaningful knowledge and as a result transfer the knowledge to applicable and new situations in the future.

The interaction or contextual effect resulting from the above instructional strategy becomes more crucial when the educational task or content has a negative valence for a particular individual. The assumption here is that quantitative subject matter generally has a negative valence for non-technical students and a transformation in valence from negative to positive is what's being sought. This transformation can be realized by embedding the educational task in a context that becomes "personally relevant".

Contextualizing Instruction:

Preparing alternative context lessons and matching them to students' interests is a time-consuming task (Ross, McCormick, Krisak & Anand, 1985) that teachers are not able to perform particularly in undergraduate education due to large class sizes. One of the most powerful features of computers is their ability to adapt instruction to learner characteristics by individualizing lessons on predetermined instructional variables. It is important to distinguish here between adapting and individualizing instructional lessons. In the literature of instructional technology, individualizing instruction implies incorporating decisions about pacing, sequencing, and selection of content which is commonly known as "learner control" or "internal control" (Hannafin & Ross, 1984) stated that "learner control" or "internal control", is adaptive if students have the knowledge and motivation to make correct decisions about their learning needs). Programmed instruction is an example of individualizing instruction that is based on "program or external control" (Ross & Morrison, 1988). The learner is branched to the appropriate lesson segment depending on the evaluation of the learner's performance. Several criticisms of program-controlled instruction have been levied by critics including Hannafin (Hannafin, 1984), and Ross & Morrison (Ross & Morrison, 1988), concerning the accuracy of the designer's judgement on when and how to direct the branching process, and the reliability and validity of the evaluation criteria.

Adapting instruction is adjusting the educational task or activity to students' prior knowledge and needs or relating the instruction to students' goals and interests. It can be achieved through various instructional strategies one of which is adapting the content of the instruction to learners' interests and preferences (different situations) known as contextualizing instruction. *It is anchoring the lesson in an authentic context that promotes personal relevance.* If the learner perceives that significant personal needs are being met by the instruction then relevance will be increased (Keller & Suzuki, 1988), and the learner will be more motivated to engage in the learning task. This would facilitate the assimilation and integration of new knowledge by associating the task with familiar and personally meaningful events (Ross, 1983).

Another instructional strategy that claims to be adaptive and flourished with the onset of Computer Assisted Instruction, (CAI), is personalizing instruction. Personalizing instruction is incorporating personal information about the student such as birth date, names of familiar people, hobbies, and other specific events into the instructional lesson. Personalization of instructional material in most commercial software is a piecemeal approach to adapting the context to students' individual interests and can create a false facade of personal relevance which may result in shallow processing of the content rather than conceptual understanding and transfer of knowledge. Personalizing is adaptive only to the extent of providing *personal relevance* through recognizing individual characteristics and interests and not through contextualizing the task to individual interests.

The above adaptive strategies are necessary but not sufficient to create the appropriate balance between individual interest and situational interest. Contextualizing instruction in this study goes a step further by adapting the content to a personal, social, or environmental context that has real-world significance and an applied focus or goal. It anchors the abstract concepts of the educational task in a situation that has a theme and a goal. For example, let's assume that the most preferred context for learning statistics for a particular student is pop music. Instead of presenting the statistical concept of MODE as the score which has the highest frequency in a distribution, it would be presented as the number of weeks that Michael Jackson maintained his single hit at number one in the charts (presuming that he had the highest frequency amongst a group of artists during a specified time period). Other related content would be presented using the

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same theme. A goal would be to compute the percentile ranks of the artists' hits as they move up and down the charts. Embedding the content in a personally relevant theme and giving it an applied goal minimizes the problem of "disconnected knowledge" and maximizes the opportunity of learning "knowledge as information to be applied or used" (Perkins, 1992).

Foundational Research:

Several studies were done by Ross et. al. (Anand & Ross, 1987; Ross, 1983; Ross, McCormick & Krisak, 1986; Ross et al., 1985) to determine the effects of adapting the context of quantitative material to student interests and background as well as personalizing arithmetic material to elementary school children using computer-assisted instruction. Adapting instruction in the above research studies consisted of adjusting or matching the examples of the subject matter to identifiable student variables or needs such as prior knowledge, academic major, and individual interests.

In one experiment, preservice teachers were given a lesson on probability using three context treatments: abstract or non-adaptive, an education context and a medical context. The preservice teachers matched with the education context performed better than the abstract and medical contexts on immediate and delayed near transfer problems (context related problems), and better than the abstract group on far transfer problems (novel situations). Another experiment was conducted to validate the adaptive context strategy to students' background by providing nursing students with the same material. The results were equally effective. The group of nursing students that was matched with the medical context performed better on all learning outcomes. The bottom line was the relevance of the context to the subjects' interests. Ross et. al. (Ross et al., 1985) furthered the research on adaptive instruction by testing whether *individual-based context selection* (learner-adaptive group) was more advantageous than *group-based context selection* (standard-adaptive group). In the individual-based approach students were asked to rank-order (from most to least favored) four areas (education, medical, sports, and abstract) that were used as contexts for presenting word problems. Students were either matched with their most favored choice during instruction (learner-choice adaptive strategy) or their least favored choice (learner-choice nonadaptive). The group-based approach used a standard-adaptive strategy by matching an entire group of subjects to the context that represented their academic major (using two separate experiments, nursing majors were assigned the medical context and education majors were assigned the education context). The hypothesis was that a medical context would be more favorable to nursing majors and an education context more favorable to education majors and consequently more meaningful learning would occur. A standard-nonadaptive strategy was administered as a control in which the assigned group(s) received the word problems in an abstract context (the word problems did not reflect any real-world application of the mathematical concept under study). The results favored the adaptive treatments on a variety of achievement and attitude measures with particular positive effects on transfer measures in one adaptive group. *No differences were reported between the individualized and the group adaptive strategies.* The authors indicated that the homogeneity of each group and differences in prior knowledge may have contributed to those results. The authors also pointed out that the contexts for the learner-choice adaptive and standard adaptive groups were almost identical because nearly all the subjects in the learner-choice adaptive groups selected the same context as the standard adaptive groups. In a previous study, Ross et. al. (Ross et al., 1985), reported similar findings and attributed the no-difference on achievement measures between learner-choice and standard adaptation strategies to yet another factor and that is the limitation of context options.

The above research findings clearly indicate the benefits of adapting context to students' interests but they do not clarify whether the benefits were due to the personal relevance of the context to the learner. The contexts provided in the above experiments were based on students' academic major and not on knowledge domains that could represent personal, social, or environmental dimensions of the life space of an individual. Individual-based selection and adaptation of most preferred context was not favored as a unique strategy but the overall posttest mean difference between learner-choice adaptive and learner-choice nonadaptive was 18.8 (78.3 - 59.5) versus 8.5 (69.4 - 60.9) for the group-based adaptive and non-adaptive strategies (Ross et al., 1986).

A contrast in the application of context to instruction was investigated in a series of studies by Bransford & Johnson (Bransford & Johnson, 1972). The studies provided evidence on using prior knowledge as a tool to aid comprehension. The major assumption was that *"contextual information is necessary for the ongoing process of comprehension"* and that prior knowledge must be semantically encoded (related to prior or familiar knowledge) to become usable and accessible in new situations. The experiments involved the interpretation of the underlying structures of abstract sentences and the treatments were varied using a Context Before reading the passage, Context After reading the passage, and No Context Before or After reading the passage. The context was provided using an appropriate picture. Other experiments used a topic for the passage to activate a suitable context. Results showed that using the Context Before (providing the context before the passage), greatly improved comprehension and recall scores. Bransford and

Johnson suggest that contextual cues must be present at input in order to aid comprehension. The data also provided evidence that students who were not provided with the context (picture or topic in this case) prior to reading the passage were actively searching for a situation to anchor the passage in. The topic and the picture helped the students activate semantic contexts of prior knowledge by functioning as a mnemonic device (Lachman et. al. (Lachman & Pompi, 1967; Lachman & Dooling, 1971) suggest that knowledge of the topic facilitates retention by functioning as a mnemonic device. Bransford and Johnson (Bransford & Johnson, 1972) however view the role of the topic as something more than generating associations and that is to aid comprehension through creating meaningful contexts of abstract information).

The above experiments provided context as an advance organizer to help relate incoming information to prior knowledge in a meaningful manner. Depending on the type of advance organizer, there could be several interpretations of the content. Even though the key issue was the timing of presenting the context rather than the choice of context, the effects of contextual content on knowledge comprehension were verified.

Renninger (Renninger, 1992) conducted a study on interest and mathematical word problem solving using a population of fifth and sixth graders where a total of 12 word problems, 3 with interesting contexts and 3 with noninteresting contexts at the student's mastery level, and 3 with contexts that were *identified interests* and 3 with contexts that were *identified noninterests* at the student's instructional level. In other words, the mastery level word problems were based on situational interest and the instructional level word problems were based on individual interest. The dependent variables were accuracy and type of error committed. Findings revealed that students were more accurate in completion of mastery than instructional problems. Individual interest and gender had a joint effect on the type of error committed. For example, boys made more error in setting up noninteresting problems (presumably because interest is more likely to assist in understanding these problems) and girls made more errors in setting up interesting problems (presumably because interest is more likely to be a distraction than an aid on these tasks). On a similar interest and reading study, students had an easier time engaging in (or being distracted by) contexts of interest than contexts of noninterest. Renninger's research seems to suggest that individual interest generates task engagement based on the challenges that students set and the kinds of questions with which they feel most familiar with, whereas situational interest is more spontaneous and can cause interest by surprise and therefore produce unexpected results in certain situations. Further analysis suggests that individual interest tends to have long-lasting effects on a person's knowledge and values while situational interest may have only a short term effect and marginally influence an individual's knowledge and values (Hidi, 1990; Hidi & McLaren, 1990). Renninger's research strengthens the argument that each type of interest has its own drawbacks and that's more of a reason why the interaction between situational interest and individual interest is crucial.

Purpose of Study:

Capitalizing on the significance of the effects of contextual information on knowledge acquisition and transfer, and the varied effects of individual interest and situational interest on promoting task engagement, the purpose of this dissertation study is to 'tease out' the confounding factors that dampened the effectiveness of individualized (learner-choice) adaptive strategies in the Ross et. al. (Ross et al., 1986) study by eliminating group-based standard adaptive approach, expanding the interests inventory of contexts based on identified students interests, anchoring the content of quantitative subject matter in the identified contexts, and allowing individual choice of context at the time of instruction. This study attempts to show that providing interesting contextualized choices will have a causal effect on personal relevance and knowledge acquisition.

Research Question:

Will adapting CBI of introductory undergraduate course content to a student's most interesting context, increase relevance, and facilitate knowledge acquisition and transfer, versus adapting to a student's least interesting context or non-adapting?

Subordinate Questions:

1. Will adapting CBI of introductory undergraduate course content to a student's most interesting context increase relevance of content?
2. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve attitude toward the content?
3. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve achievement on recall measures?

4. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve achievement on application or near transfer measures?
5. Will adapting CBI of introductory undergraduate course content to a student's most interesting context improve achievement on inference or far transfer measures?
6. Does the most interesting context for a particular individual vary from one lesson to another?
7. Is there an interaction between the context of the lesson and the context of the achievement measure?
8. Is there an interaction between the context of the lesson and the level of learning outcome being measured?
9. Is there a relationship between the student's academic major and his/her choice of context?

Methods & Procedures:

A pilot study was conducted to test the main research question above and some of the subordinate questions. This section will describe the design, the methodology and the results of the pilot study.

Pilot Study:

Design:

. The design of the pilot study was a one factor quasi-experimental design with a pre-post measure on the dependent variable relevance and a posttest-only measure on the dependent variable knowledge acquisition and transfer.

Subjects:

The subjects were a heterogeneous group of undergraduate students enrolled in computer science 100, an introductory "service course" that familiarizes students with general computer applications (word processing, data base management, and spreadsheets). The subjects participated in this study as part of completing class assignments but were provided with an alternative assignment if they did not wish to participate.

Medium:

The instructional lessons were developed using authoring tools to produce computer-based instructional modules. The content, which was elementary statistics, was contextualized to eight domains: sociology, the arts, daily life, business, science, education, music, and fiction (see sample below). There was also an abstract lesson. Each context was composed of one lesson which contained 3 modules: central tendency & skewness, variability, and z-scores and the normal distribution. The treatments were identical in size, length, screen layout, and content sequence and complexity.

Method:

140 subjects were randomly assigned to 3 treatment groups: learner most preferred adaptive: subjects were administered the most preferred choice of context, learner least preferred adaptive: subjects were administered the least preferred choice of context, and non-adaptive or abstract group: subjects were administered the abstract lesson (no context). Subjects in all three groups were asked to select their most preferred context based on "the desirability of the domains as contexts for statistics lessons". Then they were asked to rate the remaining domains on a scale of 1 to 5 from most interesting to least interesting. There was a brief explanation of each context to facilitate the selection and rating process. An attitude/motivation survey was administered prior to and after the treatments to assess any change in students' attitudes/motivation towards statistics. The survey was an adaptation of two highly reliable attitudinal surveys: Keller's IMMS (Instructional Materials Motivation Survey) which had reliability estimates of 0.96 using a Cronbach alpha measure, and Roberts (Roberts & Bilderback, 1980) SAS (Statistics Attitude Survey) which had reliability estimates of 0.90 using the Spearman-Brown formula. The questions selected from both surveys were aimed at measuring students attitudes towards statistics and the perceived relevance of statistics to students' interests and experiences. Included in the pre-treatment survey were demographic questions asking students about their background (major, profession, age, and number of prior statistics courses), and general questions assessing students' degree of familiarity with the statistical concepts to be taught in the instructional modules. An abstract, or no-context achievement posttest, testing recall, application, synthesis, and evaluation of the statistical concepts learned in the CBI lessons was administered at the end of all 3 treatments.

Results:

14 students dropped the course prior to conducting the study. 12 students did not participate in the study. 114 students completed the pre-attitude survey. 81 students out of the 114 completed all parts of the study. The 28% attrition

rate was largely attributed to the fact that the instructor of the course had given the students the option of dropping one of their assignments for the semester and participation in the study was considered as one assignment. The researcher believes that the motive for participation became almost voluntary due to the criteria set by the instructor.

Out of the 81 complete records compiled from the study, only 28% selected their most preferred context in direct relationship to their major. This supports the principle that individual interest changes and that students' interests are not necessarily related to their academic major. In other descriptive statistical analysis, the study showed that 28% of the subjects (28 seems to be the magic number here) selected 'daily life' as their most preferred domain, followed by 24% for 'sociology', 14% science, 12% music, 11% fiction, 10% business, 1% education, and 0% selected 'the arts'.

No significant differences were reported on the dependent variable "relevance of statistics" and/or "attitude towards statistics" when using a single factor ANOVA with the independent factor being gain scores reported from the pre-post attitudinal survey. Further analysis is required to test whether there were any specific changes on selected components of the attitudinal scale such as professional relevance, personal relevance, educational relevance or general confidence in one's abilities towards the subject matter. The Cronbach alpha measure on the attitude instrument was 0.920.

The p-value reported on the dependent variable achievement, was 0.10 using a 95% confidence interval with the means being: 12.17 for the abstract (control) or no-context group, 11.42 for the least preferred adaptive, and 10.19 for the most preferred adaptive. The variance for each of the levels was: 13.01 for the abstract (control) group, 15.37 for the least-preferred adaptive group, and 8.29 for the most-preferred adaptive group. Further analysis on the posttest items showed a p-value of 0.05 on application questions, and a p-value of 0.09 on the synthesis and evaluation questions combined. No significance was reported on the recall questions. The estimated reliability measure on the achievement posttest was 0.672 using a KR20 index. The overall posttest mean was 11.26% and the distribution of the test scores was clearly normal. A correlation of 0.40 was reported between the pretest measure of 'the degree of familiarity or knowledge of basic statistical concepts' and the achievement posttest scores.

Discussion:

The results of the pilot study suggest that it may be more useful to look at interactions rather than main effects. The variations obtained on the different learning outcomes on the achievement scores (p-value of 0.05 on application measures, 0.09 on evaluation/synthesis measures and 0.6 on recall measures) indicate that the independent variable may have greater effects on interactions between groups and types of learning outcomes. The high within group variance suggest that individual differences in aptitude, prior knowledge, and learning styles may have played a major role in masking a significant main effect. The experimental population was truly heterogeneous. In the Ross et. al studies (Ross et. al, 1986 #14) the groups were homogeneous in that the individuals in a particular treatment group had the same major and were at the same college level. A larger n is therefore required to detect significance in a heterogeneous population. Finally, a closer look at the CBI treatments revealed that they had minimal user interactivity. Emphasizing context as the primary instructional strategy, the treatments did not incorporate any other instructional strategy that promoted "mental effort" (Salomon, 1983a) defines the construct of "mental effort" as "the number of non-automatic elaborations applied to a unit of material", p. 42) and engagement. The treatments could best be described as "contextualized tutorials" or page turners.

Based on the above findings, the following design improvements will be implemented in the actual dissertation study:

- due to the extremely high variance of the three groups, a larger sample of subjects (at least twice the size of the pilot sample) will be used to be able to detect better significance;
- to justify that attrition is consistent and congruent among the three treatment groups, random assignment of subjects will be done at the time of CBI instruction by randomizing the treatments instead of the subjects;
- to improve the internal validity of the study, the subjects will be selected from an introductory statistics class (Statistics 200), and the CBI will be given as an independent study module that will count as homework credit;
- two contexts will be eliminated due to their low ratings: 'the arts', and 'education';
- the remaining contexts (sociology, science, daily life, business, music, and fiction) will be carefully examined in terms of their personal, social, and environmental implications and will be restructured to form distinctly relevant and non-relevant contexts for the experimental population;
- the achievement posttest will include questions from each of the context areas to find out whether subjects will do better on test items that match their lesson context;

- to enhance mental effort and task engagement, an inquisitory dialogue will be used when presenting the stimulus (instead of the story-telling approach that seemed to be prevalent in the pilot study treatments), and practice questions with corrective feedback will also be incorporated;
- since significance was better approached when analyzing the scores on the posttest based on subscales of learning outcomes, the posttest questions will be better delineated to be able to measure three distinct learning outcomes: recall, application, and inference.

Implications on Teaching and Learning:

Many schools are faced with the problem of delivering consistent, high quality, low cost introductory courses. An entire course (including lectures, text, computer guided instruction, item pool for exam-generation and a handbook for teaching assistants) which could be administered at relatively low cost, should prove highly marketable.

To maximize the efficiency of information transfer and to encourage students to view service courses as an added skill rather than a drudgery, the instructional design strategy of "adapting instruction to students' most personally relevant context" described above can be implemented to deliver a high quality course to an increasingly heterogeneous mix of students.

Other instructional variables such as structural features of the content, lesson sequencing and pacing, and type of feedback can also be manipulated using this adaptive strategy to support a more student-centered approach. The researcher maintains though that contextualizing content of quantitative subject matter remains the primary variable in promoting meaningful learning. Further investigation of this instructional strategy through an enhanced study is currently underway.

Sample of Contextualized Instruction

Introductory screen of a statistical lesson contextualized to the music domain:

You are working for the WKRZ radio station, and your mission is to do a market analysis to find out what type of music should WKRZ play, and at what time of the day, in order to attract the largest share of college students. You want to be able to tell potential advertisers that WKRZ has a high volume of young listeners as a target population. You conduct a survey on a random sample of college students and you include questions such as:

1. What type of music do you listen to? (classic rock, rock, new wave, etc.)
2. What time of day do you mostly listen to the radio and to what station?
3. How many hours per week do you listen to music in general?
4. What proportion of weekly hours do you spend listening to the radio?
5. How much money do you spend per semester on CD's? tapes?

Introductory screen of the same content contextualized to the business domain:

You are working for an investment company (Wall Street One) and your mission is to do a market analysis to find out what type of investment packages should Wall Street One set up, in order to target middle income families in the area. You want to be able to compete with already existing and established investment packages by offering a leading edge that is specific to your target population. You conduct a survey on a random sample of middle income families in the area and you include questions such as:

1. How much money do you spend on investments such as stocks, bonds, IRA accounts, etc., per week?
2. How many hours per month do you spend managing your investments?
3. How much money do you spend per week paying off credit cards and loans?
4. What time of day do you mostly talk to your investment agent or brokerage firm concerning questions and developments of your investment accounts?

Introductory screen of the abstract or no context lesson:

You have conducted a survey on a random sample of a target population and you want to describe the data resulting from the survey using some basic statistical measures that are typical of the values in the data set.

You cannot possibly list all the values you collected because there are too many. So you want to make sure that your analysis is indicative of the trends of the target population that you surveyed.

You asked many questions in your survey such as:
1. The number of hours they spend doing some activity per week.
2. The time of day they spend doing that activity.
3. The cost of doing the activity in dollars per week.
4. The proportion of time they spend on some activity verses other activities.

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